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BOSTON SOCIETY OF CIVIL ENGINEERS

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PAPERS AND DISCUSSIONS

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THE EUROPEAN ECONOMIC OUTLOOK

By E. J. Mehren*

(Presented before the Affiliated Technical Societies of Boston on November 19, 1924)

During the last ten years we in America have developed a new interest in Europe. When our goods went there before the Great War they seemed to us merely to sink into a great abyss. Somehow the money to pay for them came back, and all was peaceful. We had but little reason to speculate about the probable effect upon us of European disturbances.

Then came the War. The vacuum into which our goods had flowed was suddenly closed to us. As a result, there was serious economic disruption here.

Soon, however, under the stimulus of the conflict, the flow of goods to Europe was resumed and our exports became tremendous in volume. When the War stopped, there was hesitation for a while, but again the flow got under way. Since 1920, however, there has been almost constant disturbance because of uncertainty and changing conditions abroad.

The Europe that eleven years ago was a vague continent, somewhere beyond the salt seas, today is a sharp reality to Americans, and has been ever since that fateful August of 1914.

Particularly do our farmers and our producers of raw materials realize that what Europe is economically, so, in some proportion, are we. If Europe is prosperous, it will heighten our prosperity. If Europe is depressed, it will deepen our depression or reduce our prosperity to a lower level. If Europe is unstable, our business conditions will be disturbed and unsteady.

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* Vice-President, McGraw-Hill Company, Inc., New York.

It is true that our home markets absorb the greatest part of our production. It is true, also, that some industries are little, if at all, affected by what happens in Europe. But, speaking generally, the whole American business structure is affected by what happens abroad, and therefore European economic developments concern, directly or indirectly, every individual in this country.

This is why Americans in the last ten years have developed a new interest in Europe. This is why in 1920 I went abroad to study economic and business conditions, and why this year I repeated the trip. I hoped to be able to bring back to American engineers, business men, and manufacturers a picture of Europe during her war recovery, and to form some judgment of what the near future then held, and now holds, in store for her.

Not Posing as a Prophet

In speaking on the European economic outlook I do not pose as a prophet. You know, as well as I, the danger of making predictions. However, we can judge the future to some extent by the past. It is, indeed, our only criterion. If we review the conditions that existed in 1920 and those that obtain today, we can determine a trend and then judge by present influences whether that trend is likely to continue. It is only in attempting to discover that trend and in viewing it in the light of present influences that I shall attempt prediction.

The dominant countries of Europe in the modern commercial world are England, Germany, and France. Their disturbances are the ones that most affect us. I shall confine my remarks to these dominant countries.

War Still Current History

To us in America the War seems now to be quite remote, though its influences are still felt in various ways. The six intervening years have restored us to a remarkable prosperity. In Europe it is not so. In fact, one might say that the War is still current history in Europe, because of the deep influence it still exercises on the lives of those nations. To some extent this was to be expected. Europe was in the War longer than we. Her sufferings in every way were greater than ours. Her losses in men killed and disabled were very large. Her industries were longer disrupted, her debts much greater. In France and Belgium, in addition, there was great physical destruction.

GREAT BRITAIN

And if, throughout Europe, the War seems to be a very near yesterday, this is particularly true in Great Britain. Of the three leading European countries she displays the greatest depression, the most serious after-war effects. Germany and France, by contrast, seem much farther on the road to recovery.

This naturally causes one surprise. One would expect the most disturbed condition in Germany. Instead, one finds it not in the country of the vanquished, but in that of one of the victors.

One's surprise, of course, disappears to some extent when fundamentals are studied. Then it is disclosed that financially England is in much better condition than Germany or France, and that she has been building a solid base for her business and social structure.

The explanation of English conditions is not difficult to find. By contrast with the present, the England of 1920 was a busy England. It is true that the taxes were heavy, that industries and the workers were not fully readjusted to peace pursuits, and that disturbing false social doctrines were in the wind. But the Englishman in 1920 looked on these as inevitable consequences of the War and felt that the discontent would pass, the industrial adjustment be gradually made, and the taxes be lightened. But business took a bad turn. The feverish post-war trade revival collapsed there as it did here. The ranks of the unemployed jumped to enormous proportions — to such proportions that state aid to the unemployed, even beyond the provisions of the unemployment insurance scheme, became necessary. From that trade depression England, unlike us, has never recovered.

It is to be remembered that England is dependent upon foreign trade for her prosperity. Many of her pre-war customers have been impoverished, and to some extent industries have been developed in the countries to which England formerly sold goods, and now take care of domestic needs. Consequently, unemployment has been large ever since 1920. It is still large, the count this summer being 1,300,000. Taxes are still very heavy, the income tax on even small incomes being 4 shillings, 6 pence per pound sterling, or 22½ per cent. The supertaxes are very heavy and prevent needed reinvestment of income in new and in existing industrial enterprises.

These conditions alone — poor business, much unemployment, and high taxes — are discouragements enough. But they take second place in their impression upon the observer. Another matter presses for primary interest, because in season and out of season it is impressed on the visitor. It crops up in every discussion of England's economic conditions and England's future. That matter is the socialistic attitude which has developed in the ranks of the workers, encouraged by the politicians of both the Liberal and the Labor parties.

Engineers, manufacturers, merchants, bankers and publicists were agreed in their comment. According to these Englishmen, large groups of the working class have lost their sense of self-dependence and are being pauperized. Politicians have taught them to look to the State to take care of them in the rainy day. Accompanying this attitude is the inevitable indifference toward their work, carelessness and inefficiency. This to the British business man is the most discouraging of the conditions he must face.

By far the most lamentable feature of the social outlook is that no one sees early relief. Vigorous exposure of the present economic fallacies, at least in a widespread way, is not in hand. The Englishman is pursuing his traditional way of letting things work themselves out. Such an attitude would be inconceivable with us. We would be earnestly searching for possible solutions, and putting behind our inquiries and the resulting plans all the energy of which we were capable.

Possibly the recent victory of the Conservatives at the polls is a sign of an awakening public conscience and a signal for a vigorous handling of these social questions.

The sole responsibility for the present industrial conditions in England does not rest with the laboring classes. The British manufacturer must bear his share. He has not done his part in equipping his plants with the most modern labor-saving machinery. In America we use four horse power per worker. Great Britain uses less than one-half this amount. The lower wage in England is not sufficient to offset the savings that can be effected through the use of machinery.

Britain's Financial Policy

For whatever discouragement is due to the heavy taxes, we must remember that England has deliberately brought the present conditions upon herself. She has, in sharp contrast with her inaction on the social problem, endeavored to get back to a gold basis. She has from the very close of the war balanced her budget, which includes the very heavy charges of her war obligations. She has manfully met our suggestion and has funded her war borrowings from the United States and is making her payments regularly. The moneys she thus collects, and the great funds she has expended in public works in order to give work to the unemployed, are sums that might otherwise be diverted back into industry for the broadening of English industrial enterprise, for re-equipping her mills and factories, and thus putting them in a better position to compete with the efficient workshops of other nations.

England is surely faced with a readjustment of her industries to the quickened productive capacity of the rest of the world. She is the mother of the industrial era. Hers was the discovery and early development of steam power. She must stand or fall by the standards of the era she has created. She can continue her strong position in the industrial world only if she can produce goods of a superior quality for a given price, or goods of a given quality for a lower price. Until that doctrine becomes an active governing policy in British industry, to the extent of using labor-saving machinery as far as possible and working diligently, with consequent higher output per man, England is certain to suffer in the world's markets and to have industrial difficulties.

GERMANY

From England I went to Germany. All during last winter I had read of the hunger, particularly among the working classes, and of the critical condition brought about by the utter disappearance of the old mark and the establishment of the new Rentenmark current. Having seen the gloom and the undernourishment of 1920, I expected to find a nation terribly depressed, even in despair.

Instead, the conditions were decidedly encouraging. There is no starvation and suffering, but, most important development of all, the German people have regained their confidence. They believe that Germany is on the upgrade and that she will again win an important place for herself in the affairs of the world. That regaining of her confidence is the remarkable change, the outstanding development since the Germany of 1920.

In order to appreciate the magnitude of the German strides, let us recall briefly the picture of Germany's economic circumstances immediately after the World War.

She had lost heavily of her iron and coal deposits — in Alsace Lorraine, the Saar and Upper Silesia; she had lost her colonies, her foreign investments, her shipping, her export organization and its connections. A goodly part of her wealthy territory was occupied by her former enemies. In addition, she had been through an exhausting war and a political revolution.

The result was what might have been expected, — an underfed, discontented people, a disorganized industry, and an all-pervading discouragement that bordered on despair. These were the conditions that existed and that I observed in the summer of 1920.

But following that year there were further disasters. The Ruhr was invaded and occupied by France; efforts were made, with French support, no doubt, to break the Rhineland away from Germany and erect it into a separate state; Bavaria was in danger of leaving the German Republic, and the mark had fallen and disappeared.

With these added calamities one would expect that conditions would be much worse now than they were in 1920, and that the discouragement had given way to absolute despair.

Instead, one found a nation distinctly on the up-grade, with its confidence returned, with its budget balanced, its finances in a state of improvement.

Reason for Improvement

What is the reason for this extraordinary change?

It is due to just one cause, — the establishment and stabilization of the new currency, the Rentenmark. (In saying the new currency I refer to that which was established after the old mark disappeared. Now there is still another currency, that established under the Dawes plan.)

Just about a year ago the German government determined that the time had come for a definite decision as to the course Germany was to pursue. She was at the cross-roads. There were two paths ahead. The first was the one she was traveling, — the road of unbalanced budgets, of falling currency, of discredit in the financial capitals of the world. At the end of that path was inevitable revolution. It was the broad, easy route, but destruction lay at its end.

The road to the right was the road of balanced budgets, of economical operation of government, of higher taxes, of stable currency leading to financial health. But it was a hard and thorny road. There was possibility of precipitating immediate disorder, possibly revolution.

The government determined to throw its fortunes in with the righthand road. The old mark was, by decree, stabilized at 4,200,000,000,000 to the dollar. There was a severe contest with the mark speculators, but by drastic measures the government won, and since November, 1923, legally, and about January 1, actually, the Rentenmark has stood at 23.8 cents to the dollar. The disorders that were feared did not eventuate. There was no revolution.

That achievement marked the turn. It showed the return of administrative strength to the German government. It restored business to a sound basis. It killed speculation and the orgy of spending. It restored the incentive to save and therefore to work. It marked the end of the crisis in the economic and social disease, and the beginning of recovery.

Germany's Future

Of course, the road ahead of Germany is not easy. She will have great difficulties to overcome. Some of them I have enumerated in reciting the conditions brought on her by the War and the peace treaty. Her greatest handicap at the present time is the lack of credit. The great credit reservoirs were nearly or entirely wiped out by the fall of the mark. There was no incentive to save; industries and individuals converted the falling mark into goods as quickly as possible. Last summer the credit resources of the banks were estimated at one-tenth of the pre-war amount. As a result interest rates were from 2½ to 5 per cent per month.

This condition under which Germany has labored during the last year will, of course, disappear to a large extent through the operations of the Dawes plan. The loan of $200,000,000, or approximately 800,000,000 gold marks, will allow a credit structure to be erected on that base of, say, 4,000,000,000 gold marks. This should prove for the present an ample credit base, and should very greatly help the German recovery.

But there are favorable conditions, too.

Wages are at approximately pre-war levels. Prices, as of July 15, were from 20 to 35 per cent above the 1913 level. My own judgment from talking with working men and with middle-class people was that the cost of living last summer was 20 per cent higher than before the War.

Efficiency of labor has increased notably and is still increasing. *I want to emphasize particularly that I heard no general complaint against the working man in Germany as I did in England.*

The work councils, elected by the workers, which, it was thought upon their establishment, might be hotbeds of communistic agitation, have proved, so the employers say, to be a good influence. They help to smooth out difficulties. In general, be it remarked here, Germany's face is turned away from Communism. Its Socialism is not of the disruptive order. It is what might be called a doctrine of social democracy. It has none of the radical tinge of Russia.

As an evidence of the attitude of the workers, it is interesting to note that besides increasing their efficiency, they have voluntarily agreed in many factories to increase the working hours per day.

Unemployment, while fairly large now, is not as great as that of Great Britain, and does not present the all-engrossing problem in Germany that it does in the British Isles.

The heavy taxes imposed on industry and individuals began, under the stable Rentenmark, to yield a good revenue in June, and to allow a surplus for the paying off of obligations.

In general, the impression that Germany makes upon the visitor is that of a nation that has again taken a grip on itself; that has set its face forward; and that is bound to play an important part in world affairs.

France

With this picture of German recovery and German potentialities in mind, I went to France. What, was the question in my mind, were the French going to do about it? Here was a former enemy, with a population larger than that of France, showing tremendous recuperative power and developing a tremendous hatred against France. What, in the way of practical policies, was France going to do to meet this situation?

The answer is what one would expect from sensible men who honestly face facts.

The French know what is happening in Germany. They know it better than any one else, except the Germans themselves. And, facing frankly what they see, they are developing a more moderate policy toward the Germans. There is a growing feeling that an amicable relationship is absolutely necessary. Heriot's more moderate policy than Poincaré's is an evidence of the new French point of view. He has abandoned the Poincaré die-hard attitude. He worked manfully for putting into effect the provisions of the Dawes plan, making compromises in so doing that Poincaré's party would not have considered.

One of the evidences of the desire to reach an amicable understanding with Germany is the effort which is being made — and which by this time is probably consummated — to make reciprocal commercial arrangements between the iron-mine owners of Lorraine and the coal-mine and steel-mine owners of the Ruhr. Lorraine and the Ruhr are natural economic allies. The Ruhr can get its cheapest iron from Lorraine, and Lorraine should therefore find the Ruhr its best customer. On the other hand, the cheapest coking coal supply for Lorraine is in the Ruhr.

Realizing this natural economic alliance, the masters of these natural resources have come together, and it is reported that they have satisfactorily arranged for the interchange of their products. It is expected that there were concessions advantageous to both sides, including tariff advantages. This combination of Lorraine iron and Ruhr coal should be a powerful factor in steel affairs of the world. Particularly is it likely to be a severe competitor for the British steel industry. England's steel industry is not thoroughly modernized; its workers are not as efficient as those in the Ruhr. On the other hand, the Ruhr mills have been completely revamped since the War, while labor conditions are very good.

Whatever commercial alliances of this sort are developed between Germany and France should help in the development of amicable political relationship, and certainly such a relationship would be a tremendous advantage not only to the continent of Europe but to the entire world. A strong hatred between Germany and France would continue in Europe the tinder box that went off with such terrible results in the summer of 1914.

What France wants, of course, is security, and failing to secure the pledge of English and American backing in case of future German invasion, she is working toward amity with Germany and protection through the strengthening of the League of Nations.

Reconstruction Achievements

As to the reconstruction of the devastated regions, France has made a remarkable record. The reconstruction work, except for cleaning up and paving in the towns and cities, is practically complete. Figures as of the present are not available, but as of January 1, 1924, the restoration figures were as follows: houses and farm buildings, 81 per cent; farm land, 93 per cent; factories, 91 per cent.

The population of the devastated areas, which before the War had been 4,690,000 and which had declined to 2,075,000 at the time of the Armistice, had risen by January 1, 1924, to 4,253,000.

This reconstruction is entirely a French achievement. She herself raised practically all of the money required for this reconstruction. It was a tremendous effort and reflects great credit upon the people of France. It explains, as well, France's constant insistence upon reparation payments. She was the chief sufferer, and if her budget has been unbalanced it is because of her reconstruction charges.

This reconstruction work has resulted in great industrial prosperity. Activities were not confined to the devastated regions, but extended to the factories elsewhere which supplied building materials. So great, in fact, has been French activity that she has been importing, during the last few years, about 250,000 foreign workers annually. These workers, be it noted, have been brought in with the co-operation of the French Departments of Agriculture and of Labor.

Now that the reconstruction work is drawing to a close, it will be interesting to note the result upon French industry and French prosperity. One may reasonably expect that these will suffer some decline.

On the whole, however, the outlook in France, despite her great war debt, is not discouraging. She believes with the rest of Europe that, with the Dawes plan in operation, progress will be steadily upward.

The Near Future

Observing the progress that has been made in Germany and in France, in particular, in the last four years, and recalling that while England is sorely troubled she has re-established her financial position on a stable basis, one is warranted in saying that the upward progress will be continued.

One says this now with all the greater assurance since the Dawes plan has been accepted by Germany, and since all the laws have been passed and are in force upon which the consummation of the plan was dependent. The successful floating of the $200,000,000 loan is the last step in starting Germany forward on a sound basis.

Whether the Dawes plan will result, as France hopes, in large reparation payments is questionable. There is no doubt that the reparation moneys will be collected in Germany — from the special taxes and from the railroad and industrial mortgages. How rapidly, however, these sums collected within Germany can be transferred outside and be made available to the Allies is doubtful. Germany can pay reparations only with the surplus of her exports. The extent of that surplus depends upon the extent to which other countries will buy German goods. The tendency everywhere is to put up tariff barriers against her.

It also remains to be seen just what effect the new economic régime in Germany will have upon the selling prices of German goods. Though the credit situation will be relieved by the Dawes loan, interest rates are likely to continue high in Germany for a long time. The low railroad rates that were enjoyed by German export trade before the War have now come to an end. The mortgage that has been placed on German industry under the Dawes agreement has to be met as to interest and amortization charges. Just what effect these factors will have upon German selling prices remains to be seen. The impression of those who have carefully studied the matter is that Germany for a long time will not be a particularly low-cost producer. If that be the case, the rest of the world will not be in danger of a deluge of cheap German goods, and the world trade readjustment will, without shock, work itself out.

It should be remembered in this connection, that if the nations of the world sincerely desire German rehabilitation, if they desire to see Germany pay for the destruction she wrought in Belgium and in France, they will have to take large quantities of German goods. Otherwise there will not be an export surplus and it will be impossible to transfer outside of Germany the moneys collected there.

But despite what the Dawes plan may produce in the way of reparation payments, and the effect of Germany upon world trade, there can be no doubt that within Germany itself the Dawes plan should work toward rehabilitation and substantial progress. Such restoration of Germany to economic health and economic stability is surely bound to react favorably upon the other nations of the world.

She will be a steady customer, even if she is to some extent a competitor. And, most important of all, she will cease to be a possible cause of international disturbance and a possible hotbed of communistic development.

Everything considered, therefore, the outlook in Europe is good. It is decidedly better now than it has been at any time since the close of the War. Theoretical peace has existed in the chief countries of Europe. Actual peace has been far away, because of the controversies since the close of the War. Now a really stabilized Europe seems to be in sight.

ASPHALT PAVEMENTS

By Prevost Hubbard*

(Presented before the Highway Section on May 28, 1924)

Asphalt pavements are pavements in which the wearing course consists of mineral fragments bound together with asphalt cement. The term "wearing course" is applied to a course of asphalt mineral fragments not less than 1 inch thick in order to distinguish between asphalt pavements proper and roads or pavements which have been merely surface treated with asphalt or road oils of an asphaltic nature. The asphalt wearing course, which is seldom constructed less than 1½ inches and frequently 2 or 2½ inches thick, may be laid directly on any type of foundation or on an intermediate course 1 to 2 inches thick of an asphaltic type which in certain designs is termed the binder course.

In other designs the foundation itself is constructed with an asphalt bound mineral aggregate of any desired thickness, in which case the term "black base" or asphalt base pavement is used to describe the structure. The asphalt base may be placed directly upon the proposed subgrade or upon a sub-base course of gravel or broken stone. In any event, the asphalt base is laid to a greater thickness than the usual binder course, seldom less than 3 inches and sometimes as thick as 6 inches.

Asphalt. — The principal function of asphalt in an asphalt pavement is to bind together the mineral fragments which constitute the body of the road structure. Asphalt paving cements are plastic by nature, and when used as a coating or binding medium for mineral aggregates produce a structure which is to a considerable extent flexible. This fact sharply differentiates asphalt pavements from those constructed with hydraulic cements which produce rigid structures, and has a most important bearing upon the selection of cross-sectional designs and any comparison of such cross-sections with those of a rigid nature.

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The properties which an asphalt should possess in order to function properly in a pavement structure are generally understood, and specifications for paving asphalt have been pretty well standardized. Because there are a number of different types of asphalt pavement using mineral aggregates of different degrees of natural stability, and because the consistency of an asphalt cement varies with its temperatures thus producing a variable degree of flexibility in the pavement structure, a single grade of asphalt cement cannot be used for all types of asphalt pavements. This has led to the establishment of a number of well-defined grades as determined by the hardness of the product measured in terms of the penetration test. During 1923 nine standard grades of asphalt for asphalt pavement construction were unanimously adopted by a conference of consumers and producers called by the United States Department of Commerce, and these grades are now being generally adopted throughout the country.

The success of an asphalt pavement depends not only upon the characteristics of the mineral aggregate and the asphalt cement but upon the proportions in which they are combined. The allowable variation in proportion of asphalt cement which should be used with any mineral aggregate is very limited as compared with hydraulic cements, and it is quite as serious a mistake to use too much asphalt as too little in the construction of the pavement. As a matter of fact, determination of the correct amount is just as important if not more important than the selection of the best grade or consistency of asphalt to use. The use of too little or too hard an asphalt in general reduces the flexibility of the pavement which then at low temperatures acquires certain of the inherent and unavoidable faults of the rigid pavement. On the other hand, use of too much or too soft an asphalt may increase the flexibility of the pavement to such an extent as to make it readily plastic and subject to displacement under traffic. Fortunately, however, experience and careful observation over a period of more than forty years have resulted in a standardization of practice which if conscientiously followed insures highly satisfactory results.

TYPES OF ASPHALT PAVEMENTS

There are four well-defined types of asphalt pavements each having certain characteristics which favor its selection in preference to the others for certain combinations of local conditions. In many cases, however, selection between at least two types is more a matter of preference based upon previous local experience or relative first cost than upon any other considerations. These four principal types are (1) Asphalt Macadam, (2) Asphaltic Concrete, (3) Sheet Asphalt and (4) Asphalt Block. In a paper of this nature it is unnecessary to attempt a detailed discussion of the construction of these types which have been thoroughly covered in numerous engineering papers and specifications already published. Attention will therefore be directed to only a few of the more important features relating to characteristics, selection, design and construction.

Asphalt Macadam

Without discussing reasons which in most cases are obvious, it may be stated that the following details are of vital importance in the construction and maintenance of a high class asphalt macadam pavement. The slighting of any of these details is apt to materially shorten the useful life of the pavement, although the bad effects may not begin to be seen until sometime after construction is completed.

1. The individual fragments of coarse mineral aggregate should be clean and free from dust so that the hot asphalt cement will readily adhere to their surfaces.

2. Before the first application of asphalt is made the fragments of mineral aggregate should be well keyed together by rolling, otherwise an uneven surface will develop under traffic due to shifting about. Rolling should not, however, be carried to the point of abraiding the fragments so as to produce a coating of stone dust on their surfaces.

3. Before application of the asphalt the course of broken stone should show a uniform distribution of voids. Pockets of fine material which prevent uniform penetration of the asphalt should be removed and replaced with mineral aggregate of suitable size.

4. Asphalt should be applied only when the broken stone course is dry for its entire depth, and when the weather is sufficiently warm to prevent

chilling of the asphalt at the surface to such an extent that proper penetration will not be secured.

5. Great care should be taken to distribute the asphalt at a uniform rate per square yard, both during the first application and in the construction of the seal coat.

6. After the seal coat asphalt has been applied only sufficient stone chips should be rolled in to take up the excess asphalt. Overloading the seal coat with mineral matter materially shortens its life.

7. The seal coat of the asphalt macadam should be carefully maintained, and before it has completely worn away the surface should be again treated with an application of asphalt and stone chips. Such retreatment will greatly prolong the life of the underlying wearing course.

Asphaltic Concrete

Asphaltic concrete wearing courses are composed of a mixture of asphalt cement with broken stone, mine tailings, broken slag or gravel and usually with sand and mineral filler as well. The mixture is ordinarily prepared at an asphalt plant from preheated mineral aggregate and asphalt, and while hot is laid and compressed upon the prepared foundation. Certain patented or proprietary asphaltic concrete mixtures are, however, prepared or laid without preheating the constituents. There are two main classes of asphaltic concrete known as "coarse graded aggregate" and "fine graded aggregate." In the former the proportion of mineral particles larger than ¼-inch diameter is greater than any other constituent of the mix, the fine aggregate which consists of sand and mineral filler serving principally as void-filling material between the larger mineral fragments. Because of the relatively large size of the coarse aggregate fragments, and the fact that voids are well packed with fine aggregate, the particles need not be angular. Opportunity is therefore offered for the utilization of a good grade of local gravel. This together with the fact that the sand or fine aggregate need not meet as rigid grading requirements as for other classes of asphalt paving mixtures create an advantage which in certain instances may be a deciding factor in the selection of type.

In the fine graded aggregate asphaltic concrete, on the other hand, sand or fine mineral particles which will pass a 10-mesh sieve predominate, and the larger fragments are merely suspended in the matrix of fine aggregate without being in immediate contact with one another. Fine graded asphaltic concrete is so similar in character to the wearing course of a sheet asphalt pavement as to have acquired the term "stone filled sheet asphalt." The use of gravel pebbles for coarse aggregate should be avoided as they are apt to be picked out of the surface of the pavement by traffic and leave small holes which serve as starting points for progressive surface disintegration. This class of asphaltic concrete has become quite popular in certain sections, particularly where coarse aggregate is more expensive than fine aggregate, and offers many of the advantages of sheet asphalt usually at a lower cost.

Sheet Asphalt

Sheet asphalt pavements are those in which the wearing course is composed of a mechanical mixture of asphalt cement with a carefully graded sand and mineral filler. This mixture called sheet asphalt topping is usually laid on an intermediate course of asphaltic concrete known as the binder course. The total thickness of binder and wearing courses is generally 2½ or 3 inches with a minimum thickness of 1 inch for either course. One and one-half inch binder and 1½-inch wearing course is probably the most common design adopted for the sheet asphalt pavement. The binder mixture is similar to the usual coarse aggregate asphaltic concrete, except that it carries a smaller percentage of sand and no mineral filler, as it is not necessary to completely fill the voids and it is desirable to obtain a surface texture after compacting which will permit a close bond with the wearing course. Sheet asphalt is designed to withstand severe traffic conditions and has become the most popular of all city pavements as evidenced by the yardage laid as compared with all other types. Particular attention should be paid to securing a sand for the wearing course composed of hard durable grains free from clay, loam and other foreign material, and meeting the well-standardized mesh composition or grading limitation which experience has shown to be desirable and which are embodied in most sheet asphalt specifications.

In both fine aggregate asphaltic concrete and sheet asphalt paving mixtures mineral filler plays a very important rôle. It not only serves to fill the voids between the fine aggregate or sand particles, but serves to toughen the mixture and increase its resistance to displacement under traffic. Very fine sand grains do not serve the latter purpose satisfactorily, but such materials as limestone dust, Portland cement and slate dust have proved to be excellent fillers and are usually specified for this purpose. It is ordinarily advantageous to use as much filler as the mix will comfortably carry without interfering with its uniform spreading and compaction.

Hot Mix Construction. — The most desirable consistency or grade of asphalt for use in asphaltic concrete and sheet asphalt pavements is largely determined by climatic and traffic conditions to which the pavement will be subjected. In general, the warmer the climate and the heavier the traffic the harder should be the asphalt cement. For asphaltic concrete penetration limits of 40 to 50, 50 to 60, or 60 to 70 are commonly specified, and for sheet asphalt the usual limits are 30 to 40, 40 to 50 or 50 to 60. The following construction details should be given particular attention in order to secure best results with any of the hot mix types of asphalt pavements.

1. The character and grading of the mineral aggregate should be under the constant and careful control of an inspector at the paving plant.
2. All batches of paving mixture should be correctly and uniformly proportioned preferably by weighing each constituent of the mix, and the plant inspector should be sufficiently experienced to determine just what proportions within specification limits are most desirable to adopt.
3. Paving mixture should leave the plant at such temperature, within specification limits, as will insure its arrival on the job at a sufficiently high temperature to permit of proper spreading, raking and compaction.
4. The mixture should be laid only when weather conditions are such that the surface is not rapidly chilled, thus forming a stiff crust which prevents proper compression throughout its entire depth.
5. Careful and uniform spreading and raking are essential to securing a surface of uniform contour. Carelessness in this detail cannot be corrected by rolling, and an uneven contour in a newly constructed pavement is apt to lead to rapid development of waves or bumps.
6. The hot mixture should be compressed as soon as possible after raking, and should be conscientiously continued by an experienced roller man until no further compaction is possible. Rolling should proceed at an average rate of not more than 200 square yards per hour per roller. Maximum

initial compression is highly desirable and may frequently best be obtained by using a three-wheel 10 or 12 ton roller.

7. The contour of the pavement should be tested before rolling is discontinued, and corrected where necessary by suitable means before the mixture has become cool.

Asphalt Block

The fourth type of asphalt pavement known as asphalt block is a pavement in which the wearing course is constructed of blocks composed of a dense fine-graded asphaltic concrete subjected to heavy compression during the process of moulding. These blocks are laid in regular courses as in the case of brick pavements, and vary in thickness from 2 to 3 inches. A special grade of asphalt differing in certain respects from the regular paving asphalts is required for asphalt block manufacture. Asphalt blocks should ordinarily be laid upon a ½-inch bed of cement and sand mortar, although they have been successfully used under favorable climatic and traffic conditions in certain localities directly upon a sand foundation.

Foundations

There are fully as many types of foundations which are satisfactory for use with asphalt wearing courses as there are types of asphalt pavements. Thus gravel, broken stone, Telford, Portland cement concrete, and asphalt base, commonly known as black base, all have their place in the design of asphalt pavements. Moreover, almost any type of existing road or pavement which has reached its limit of economic and useful life as a wearing surface may be utilized in some way as a foundation for a new asphalt pavement. The annual salvage value of such old worn-out roads in this country is tremendous, and a large part of the original investment in their construction is lost if the old material is removed and replaced by a new type of construction. This portion of the original investment, which for old worn-out gravel and macadam roads alone has been estimated at about $200,000,000 annually, may be conserved by utilizing the old roads as foundations for asphalt pavements.

In this paper time will not permit a detailed description and comparison of all of the types of foundations available for use with asphalt pavements. The subject of foundations will therefore be treated in a rather sketchy manner with an attempt to develop some of the more fundamental factors relating to design.

Subgrades

First of all, it is necessary to consider subgrades. For some years past much has been said and written regarding the importance of subgrade preparation and drainage, but little real improvement is to be noted in ordinary practice. It has been demonstrated that all known systems of drainage have very decided limitations of effectiveness, and that the bearing power of certain soils under natural local conditions will in spite of drainage be so low as to necessitate the adoption of relatively costly designs of pavements to carry the traffic. It is also known that subgrades composed of certain soils will with ordinary drainage successfully carry almost any traffic if their surface is protected with a thin pavement which will not shatter under impact. Economical methods of modifying the characteristics of soils of poor quality so as to greatly increase their bearing value when wet have also been known for many years as evidenced by the widespread development of the sand clay road, and yet in the construction of high-type pavements this information is not put to practical use. The subject of subgrade modification is, however, receiving the constantly increasing attention of those actively engaged in highway research, and it is to be hoped that construction engineers will soon begin to reduce the test results to practice. In the last analysis foundation construction, for flexible pavements at least, may be considered largely as a method of subgrade reinforcement.

Gravel and Broken Stone Foundations

A new gravel foundation should be allowed to consolidate and season under traffic for a period of at least six weeks before an asphalt pavement is placed upon it, and during this period it should be carefully maintained so that there will be no uneven loosely bound areas to cause breaks or depression in the asphalt wearing course. It is also highly desirable to follow the same practice where a new broken stone foundation is to be used, and during construction the voids should be filled with screenings so as to obtain as nearly as possible the same degree of stability as is found in old well-constructed macadam roads. For a 2-inch asphalt pavement a new gravel foundation should seldom be less than 8 inches thick, and a new broken stone foundation seldom less than 6 inches thick. Where the subgrade is of poor quality and the traffic heavy, considerably thicker designs should be adopted. As a matter of fact, under such conditions it is much safer to adopt some type of asphalt base with a relatively thin sub-base of gravel or broken stone.

Asphalt Foundations

There are three types of asphalt bases or foundations known as the asphalt macadam base, the asphalt sand base, and the asphaltic concrete base. Asphalt macadam base is constructed in one or two courses 3 inches thick in much the same manner as the asphalt macadam wearing course, except that somewhat less asphalt is required per inch of thickness and the seal coat is omitted.

The asphalt sand base which has been successfully used in certain sandy sections of the country, notably the eastern portion of North Carolina and in Florida, is composed of a mixture of local sand and asphalt prepared and laid hot to a compacted thickness of 3 or 3½ inches directly upon the sandy subgrade. Such a base carrying a 1½ or 2 inch sheet asphalt wearing course has proved highly serviceable and economical for light and medium traffic.

The most extensively used type of asphalt foundation is the asphaltic concrete base, which is composed of a coarse graded asphaltic concrete quite similar in character to that used for asphalt binder course, except that the maximum diameter of the coarse mineral aggregate may be as great as 2½ inches. Durable pavements have been constructed in the State of California with an asphaltic concrete base only 2½ inches thick, and an asphaltic concrete wearing course 1½ inches thick, but in most cases the thickness of the base is not less than 3 inches and may run as high as 6 inches which is then laid in two courses. Where subgrade conditions are bad and traffic heavy it is often desirable to lay a 3 or $3\frac{1}{2}$ inch asphaltic concrete base upon a sub-base of broken stone 3 to 5 inches thick. A relatively thin asphaltic concrete base may also be advantageously used to salvage an old gravel or macadam road which is too thin to be used directly as a foundation, and is thus made to serve as a sub-base.

Asphalt base pavements have become very popular in a number of our Western States due to the highly satisfactory service results which many of them have given over a long period of years; for example, there are in existence in California over 2,000,000 square yards of asphalt base pavements which have been in use for more than ten years and are in excellent condition today. It is also of interest to note that from 1918 to 1922, inclusive, over 15,000,000 square yards of asphalt base pavement were constructed in the five Pacific Coast States and that in addition over 7,000,000 square yards were constructed in those states during 1923. This type of construction is extending eastward and promises to develop rapidly as eastern engineers become more familiar with its desirable qualities. The State of Virginia has now under construction 5.5 miles of it on a heavily travelled highway leading from Richmond to Seven Pines. Six and one-half miles of asphaltic concrete base pavement were constructed last year on the Toronto–Hamilton Route in the Province of Ontario, Canada, and a number of eastern cities and counties in this country are now specifying "black base" construction. In addition, the State of North Carolina has constructed a considerable mileage of sand-asphalt base pavement during the past few years.

With the same amount of care in subgrade preparation there is probably less chance of failure in a flexible foundation such as the asphalt base than in a rigid type of foundation. This is due to the fact that because of its flexibility it seeks to maintain constant and intimate contact with the subgrade, and thus utilizes the supporting value of the subgrade to the maximum extent. Under many conditions that produce cracking in a rigid foundation the slight yield of an asphalt foundation will maintain the pavement intact.

Rigid Foundations

In entirely new construction Portland cement concrete is frequently used as a foundation for asphalt wearing courses. In cities where subgrade conditions are generally good a foundation thickness of 6 inches is ordinarily ample to carry the weight of traffic, and if precautions are taken in country highway construction to see that the subgrade is properly prepared, consolidated and drained, more than 6 inches of concrete foundation will seldom be required. In fact, where subgrade conditions are favorable 5 inches or even 4 inches of concrete may be sufficient. The mix need seldom, if ever, exceed the proportions of 1:3:6, or 1 part of cement to 9 parts by volume of total aggregate. Use of a rich concrete base is not only an unnecessary extravagance, but may actually produce less satisfactory results than the lean base. Especially where conditions tend to produce considerable movement through expansion and contraction, any cracks formed in a rich base are apt to be wider than in a lean base, thus producing open joints and corners which are known to be one of the greatest sources of weakness in the all-rigid pavement. Moreover, wide cracks in the foundation are almost invariably carried up through the wearing course of the asphalt pavement. For the same reason it is not considered advisable to place construction joints in the concrete foundation, although some tendency along this line has been manifested in recent designs of Portland cement concrete bases.

HIGHWAY INVESTIGATIONS AND RESEARCH

At this point it is desired to direct particular attention to a matter which deserves the careful consideration of highway engineers. Within the past few years a number of important investigations have been conducted in which attention has been focused upon the behavior of the all rigid pavement under laboratory and field tests. These investigations have led to decided modifications in the design of concrete pavements, intended to remedy troubles which have developed in the past, due to the formation of cracks and subsequent disintegration of the pavement under traffic. So much attention has been paid to concrete pavement design that a strong tendency has developed to view all designs through concrete spectacles and to apply to all other types of construction principles which under careful analysis may be found to be of very minor importance to such other types, particularly those which are flexible or semi-flexible in character.

Thus under ordinary conditions a very slight deflection of a rigid pavement slab under a traffic load develops a crack which is considered to be a failure as the crack starts progressive disintegration of the pavement. Yielding of the subgrade to the extent of a small fraction of an inch will cause cracking unless the slab is designed with sufficient strength to bridge this weakness in the subgrade. On the other hand, while the concrete base of an asphalt pavement cannot deflect without cracking any more than a concrete pavement, when it does it is kept in contact with the subgrade, which prevents further appreciable deflection. The flexible asphalt wearing course adjusts itself to the slight permanent deflection caused by the cracking of the base without failure of any sort, and for all practical purposes the pavement remains intact. No surface cracks leading to progressive disintegration are produced, and the slight readjustment of contour extends over a sufficiently wide area to make it practically imperceptible. It has been repeatedly noted during impact investigations that the mere cracking of the concrete base under the application of loads does not produce failure of the asphalt wearing course.

It is true that wide cracks in a concrete base are sometimes carried through the asphalt pavement, but in general cracks produced in foundations by surface loads are not wide and are no more serious than the fine cracks produced in lean bases by contraction. It is therefore hardly logical to design the concrete base of an asphalt pavement to meet the same strength requirement as for an all rigid pavement. To sum the matter up in a few words what constitutes failure in a concrete pavement does not constitute failure in an asphalt pavement. Attempts to apply the same principles of design to both types have resulted either in requiring an unnecessarily thick base which is extravagant and prevents fair competition, or in requiring an unnecessarily rich mix base which not only hinders competition but may be disadvantageous for reasons previously mentioned.

Vol. XI DECEMBER, 1924 No. 10

BOSTON SOCIETY OF CIVIL ENGINEERS

FOUNDED 1848

PROCEEDINGS

MINUTES OF MEETINGS

BOSTON SOCIETY OF CIVIL ENGINEERS

THE regular November meeting was omitted, in accordance with the vote of the Society on October 15, in order that the members could take part in the meeting of the Affiliated Technical Societies of Boston on November 19, 1924, at which Mr. E. J. Mehren, Vice-President and Chairman of the Editorial Board of the McGraw-Hill Company, Inc., spoke on "The Economic Outlook in Europe."

This meeting was a most interesting one, and was broadcast by station WDBR, Tremont Temple Baptist Church, Boston. Mr. Mehren's paper is published in this number of the JOURNAL of the Society. A buffet supper and smoker was held in advance of the meeting, the arrangements for which were handled by the Social Activities Committee of the Boston Society of Civil Engineers.

J. B. BABCOCK, *Secretary.*

DECEMBER 4, 1924.

SANITARY SECTION

BOSTON, November 5, 1924. — A meeting of the Sanitary Section of the Boston Society of Civil Engineers was held in the Library of the Affiliated Technical Societies of Boston this evening at 7.45 P.M.

The reading of the minutes of the previous meeting was omitted, as they had been previously published.

The Chairman, Gordon M. Fair, presided.

It was voted, after brief discussion, to advance the meeting hour from 7.45 to 7.15 P.M.

Mr. Philip Drinker, Instructor in Ventilation and Illumination, Harvard School of Public Health, gave a talk on "The Engineering and Physiological Significance of Dusts, Fumes and Smokes in Air." The talk was illustrated with slides, and demonstrations were given with laboratory equipment.

The attendance was 27.

The meeting adjourned at 9.30 P.M.

HARRISON P. EDDY, Jr., *Clerk.*

DESIGNERS SECTION

BOSTON, November 12, 1924. — The regular November meeting of the Designers Section of the Boston Society of Civil Engineers was called to order at 6 P.M. in the Affiliation Rooms by Chairman Edward H. Cameron.

The Chairman introduced Professor Charles M. Spofford, head of the Department of Civil and Sanitary Engineering at the Massachusetts Institute of Technology, who gave a very interesting talk upon space framework, the design of domes, and transmission towers. An interesting discussion followed the talk.

There were 47 members and visitors present.

The meeting adjourned at 7.40 P.M.

WALDO F. PIKE, *Clerk.*

APPLICATIONS FOR MEMBERSHIP

[December 15, 1924]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

For Admission

Carlton, F. Tyler, Boston, Mass. (Age 20, b. Andover, Mass.) A student at Northeastern University since January, 1923. Has worked as rodman in Shawsheen Village, under John Franklin, during the summer of 1922; rodman and transitman with J. Leslie Woodfall, during the fall of 1923; and surveying with Aspinwall & Lincoln, all of which work has been done on the co-operative plan. Refers to H. B. Alvord, L. G. Brackett, C. S. Ell, J. W. Ingalls, W. E. Nightingale.

Gamble, Harold Glover, Dorchester, Mass. (Age 25, b. Dorchester, Mass.) A student at Northeastern University. Refers to H. B. Alvord, C. S. Ell, J. W. Ingalls, W. E. Nightingale.

Haskins, George Andrew, Lakeville, Mass. (Age 20, b. Lakeville, Mass.) Student at Northeastern University. Has had nearly two years experience in surveying, concrete construction, drafting and landscape engineering for R. L. Hayward, Taunton, Mass. Refers to H. B. Alvord, A. O. Bradshaw, C. S. Ell, J. W. Ingalls, W. E. Nightingale.

Lavers, W. Douglas, Salem, Mass. (Age 19, b. Carleton Village, N. S.) Graduate of Salem High School and now a student at Northeastern University in civil engineering. During work periods has been employed by the town engineer of Belmont; highway surveyor of Dartmouth, Mass.; at present with Shay & Leary, civil engineers, Lynn, Mass. Refers to H. B. Alvord, C. S. Ell, J. W. Ingalls, W. E. Nightingale, J. L. Woodfall.

Pillsbury, Arthur Milliken, Boston, Mass. (Age 20, b. Scarboro, Maine.) A student at Northeastern University in civil engineering. On the co-operative plan now employed by the City Engineer of Putnam, Conn. Refers to H. B. Alvord, A. O. Bradshaw, J. W. Ingalls, W. E. Nightingale.

Pinn, Carl Travis, Jamaica Plain, Mass. (Age 32, b. Boston, Mass.) Educated in the Dwight Grammar School, English High, and spent 18 mos. in Wentworth Institute, Berkeley Preparatory School and International Correspondence School. Spent nearly two years drafting in Colorado, 22 months with U. S. Engineers, and is now with the Boston & Albany R.R. Refers to H. A. Buck, A. L. Lampie, J. B. Otterson.

Platter, Charles Theodore, Boston, Mass. (Age 20, b. Cape Town, South Africa.) Graduate of Boston English High School, now a junior at

Northeastern University. Has been employed as rodman by Mr. George T. Sampson and as transitman for Charles H. Gannett. Refers to H. B. Alvord, C. S. Ell, J. W. Ingalls, W. E. Nightingale.

SANDERSON, PAGE, Wellesley, Mass. (Age 20, b. Parkersburg, W. Va.) Graduate of Wellesley High School, and now a student at Northeastern University. Has been employed during work periods by Aspinwall & Lincoln. Refers to H. B. Alvord, C. S. Ell, E. H. Lincoln, W. E. Nightingale.

STONE, EVERETT E., Newtonville, Mass. (Age 59, b. Lancaster, Mass.) Assistant chief engineer Boston & Albany R.R., 1894–1907; chief engineer 1907–1910; contractor, 1910–1913; member Public Utilities Commission, State of Mass., 1913–1924. Refers to C. R. Gow, H. W. Hayes, Allen Hazen, E. E. Lochridge, E. H. Rogers, G. F. Swain.

WITHERELL, ROGER GUSTAVUS, Taunton, Mass. (Age 22, b. Taunton, Mass.) Is a student at Northeastern University, and during working periods has been employed by C. F. Joy of Milton, and R. L. Hayward of Taunton. Refers to H. B. Alvord, C. S. Ell, J. W. Ingalls, W. E. Nightingale.

LIST OF MEMBERS

ADDITIONS

BREITBEIL, CHARLES E.	67 Lennox St., Nahant, Mass.
CRANDALL, JAMES L.	283 Fellsway East, Malden, Mass.
HOOPER, MORTIMER B. A.	11 Beacon St., Rm. 1224, Boston, Mass.
SHURTLEFF, ARTHUR A.	11 Beacon St., Boston, Mass.
TSAGARIS, DEAN P.	12 Lagrange St., Lowell, Mass.

CHANGES OF ADDRESS

ADAMS, HENRY S.	100–1 Ames Bldg., Boston, Mass.
BRADSHAW, ALFRED O.	408 State House, Boston, Mass.
CLEVERDON, HERBERT S.	117 Grant Ave., Newton Center, Mass.
CONANT, ELBRIDGE R.	c/o Luther Conant, Jr., 91 Bacon St., Winchester, Mass.
FARROW, HIRAM P.	Rockland, Maine.
JOHNSON, HENRY D.	243 Academy Ave., Mount Lebanon, Pa.
MCCARTHY, EDWARD R.	16 East Hall, Tufts College, Mass.
PARKER, EDWIN S.	30 Upland Rd., Brookline, Mass.
PERKINS, CLARENCE A.	Centerville, Mass.
SAVAGE, J. DANA	202 Main St., Waltham, Mass.
WYNER, HENRY I.	9 Batavia St., Boston, Mass.

DEATHS

GAVETT, ANDREW J.	May 25, 1924
ROOKS, CLARENCE H.	Dec. 3, 1924
WHIPPLE, GEORGE C.	Nov. 27, 1924

LIBRARY NOTES

BOOK REVIEW

"DETAILING AND FABRICATING STRUCTURAL STEEL," by F. W. Dencer, C.E., Engineer, Gary Plant, American Bridge Company. First Edition. McGraw-Hill Book Company, Inc., New York. 511 pages.

REVIEWED BY H. L. BOWMAN*

The book under review presents in concise form a discussion of the problems arising in connection with the detailing, ordering, and fabricating of structural steel. After describing in outline the organization of a structural company and a structural shop, the book goes to a rather elaborate discussion of the drawing room practice of the American Bridge Company as related to bridges, office buildings, mill buildings, bridge machinery, ships, and tanks.

The above matter occupies roughly one-half of the book. The remainder of the book is largely concerned with the handling of the steel from the time it reaches the fabricating plant until it is shipped from the plant. There are sections on the templet shop, laying out, punching, reaming, and drilling, shearing, fitting, riveting, finishing, etc. The work done by the forge shop, and the machine shop is also rather fully described. This latter part of the book brings together its information in better and fuller form than is done in any other book with which the reviewer is familiar. The engineer who is interested in the production of designs which will lend themselves to economical fabrication will be amply repaid by a careful study of what the author has to say about shop practice.

Loading for shipment and loading for export are discussed. A section (the book contains sections, not chapters) which tells of a method for determining whether detailers, checkers, and squad foremen are underpaid or overpaid is worthy of special mention. The author is to be commended for resisting in such large measure the all too prevalent tendency to include a multitude of tables which every structural designer and draftsman already has available in a host of other books.

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* Assistant Professor of Structural Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

The book contains little to criticise adversely. The reviewer doubts, however, whether the return of the fabricated ship is sufficiently imminent to necessitate the inclusion of a section on it, also doubts the wisdom of including an elaborate classification of structures which takes up forty-seven closely printed pages, and further wonders what use the majority of readers will find for the lists of freight rates from Chicago to various points in the United States.

Recent Additions to the Library

U. S. Government Reports

Ports of Galveston, Houston & Texas City, Texas. Series No. 6.

Study of Pollution and Natural Purification of the Ohio River. (Public Health Bulletin No. 143.)

Precise Triangulation, Traverse and Leveling in North Carolina.

State Reports

Massachusetts. Annual Report of Department of Public Utilities. Parts 1, 2 and 3, 1922.

Massachusetts. Annual Report of Department of Public Utilities. Decisions and Findings. 1922.

Municipal Reports

Bayonne City, N. J. Report on Water Supply. Weston & Sampson.

Fall River, Mass. Annual Report of Watuppa Water Board. 1923.

Philadelphia, Pa. Annual Report of Bureau of Surveys. 1923.

Waltham, Mass. Annual Report of Department of Public Works. 1924.

Miscellaneous

Condensed Catalogue of Mechanical Equipment, A. S. M. E. 1924–25.

Detailing and Fabricating Structural Steel, Dencer. Gift of McGraw-Hill Co.

Report of Australia to the World Power Conference, London, 1924.

Structural Engineering — Fundamental Properties of Materials. Swain. Gift of McGraw-Hill Co.

Sweet's Architectural Catalogue. 1924–25.

LIBRARY COMMITTEE.

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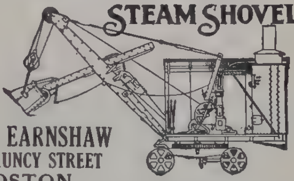

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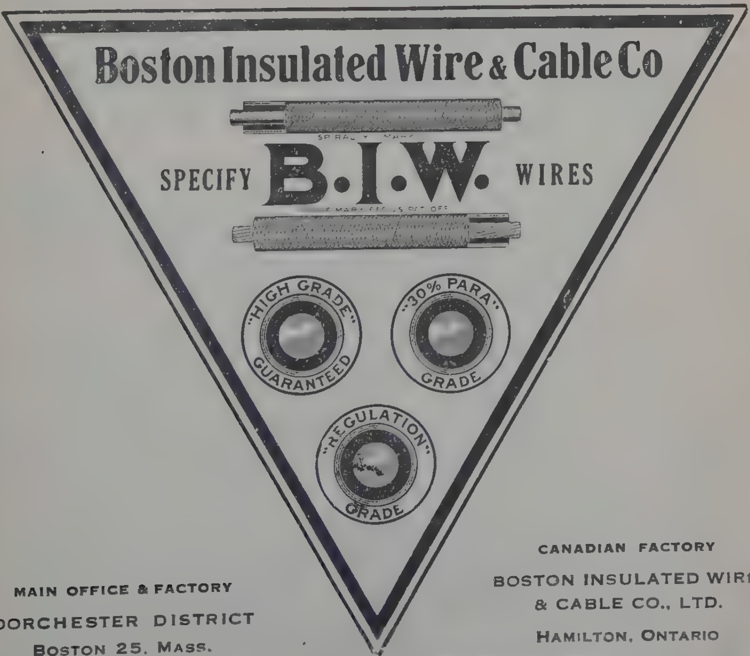

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